NASA TECHNICAL TRANSLATION NASA TT F-15,690

THE ACCURACY OF SATELLITE TEMPERATURE SOUNDING OF THE ATMOSPHERE

V. P. Tarakanova

Translation of "K voprosu o tochnosti temperaturnogo zondirovaniya atmosfery s iskusstvennykh sputnikov Zemli," Meteorologiya i gidrologiya, No. 4, April 1974, pp. 76-78

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 JUNE 1974

STANDARD TITLE PAGE

1. Report No. NASA TT F- 15690	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle THE ACCURACY OF SATELLITE TEMPERATURE SOUNDING OF THE ATMOSPHERE		5. Report Date June 1974 6. Performing Organization Code
7. Author(s) V.P. Tarakanova Main Geophysical Observatory		8. Performing Organization Report No. 10. Work Unit No.
9. Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063		11. Contract or Grant No. NASw 2481 13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D. C., 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "K voprosu o tochnosti temperaturnogo zondirovaniya atmosfery s iskusstvennykh sputnikov Zemli," Meteorologiya i Gidrologiya, No. 4, April 1974, pp. 76-78.

16. Abstract

Data are presented on the statistical structure of the errors of indirect satellite soundings at various levels in the atmosphere. Standard aerological sounding data at standard times and levels are used as the standard. Comparison of the correlations at various levels demonstrates the lowest correlation at the 200 mb level. Data are presented on correlation of errors at various levels at the same point, in which case the correlations are below the significance level. This apparently is connected with the method of processing the indirect sounding data.

17. Key Words (Selected by Author(s))	18. Distribution Statement
	Unclassified-Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	5	

NASA-HQ

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ANNOTATION

Data are presented on statistical structure of errors in indirect sounding. The presence of a spatial correlation of satellite sounding errors was revealed.

THE ACCURACY OF SATELLITE TEMPERATURE SOUNDING OF THE ATMOSPHERE

V. P. Tarakanova

Indirect methods of thermal sounding of the atmosphere have been /76* developed much recently, in particular, sounding from satellites. According to the data of a number of authors [5-7], the accuracy of reconstruction of the temperature profile is comparable to the accuracy of aerological sounding. In this connection, satellite sounding data is beginning to be transmitted and used operationally. These data are used in analysis, together with standard aerological data; however, in this case, their singularities are not taken into account. Moreover, there is a basis for thinking that there are such singularities. In particular, as was pointed out in work [3], it can be expected that errors in satellite measurements at various points will be correlated, since they are made by the same instrument. Clarification of this circumstance is very important for inclusion of satellite data in a system of objective analysis and prognosis, in connection with which an effort at quantitative evaluation of the error structure of these data was undertaken.

Data on the vertical temperature profiles, obtained by means of processing of the spectral radiation values observed by the satellite infrared spectrometer installed on satellites of the Nimbus series, were used. The processing procedures were described in [6, 7]. Satellite sounding data were kindly presented to us by V. G. Boldyrev. The results of soundings from the end of March through August 1971 were available to us.

It is natural that some reliable estimate of the accuracy of indirect sounding could be carried out in regions, which are well illuminated with aerological data and at times, close to the times of aerological sounding.

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* Numbers in the margin indicate pagination in the foreign text.

In connection with this, we selected complete vertical profiles from the existing satellite sounding data (i. e., those when there were temperature data at all standard levels, which practically corresponded to the cases of clear weather), differing by no more than two hours from the principal aerological sounding times, i. e., 12 and 24 hours Greenwich time. For western Europe and the territory of the Saviet Union, there proved to be not a very large number of them, 157 profiles in all.

Processing was reduced to the following: data on air temperature, which we adopted as the "standard," i. e., it was considered that these data were absolutely accurate, were taken from the barometric topography maps at the satellite sounding points. The errors in indirect temperature sounding were determined with respect to these data.

Then, the statistical characteristics of these errors were calculated, including their spatial correlation function for the 850, 700, 500, 300 and 200 mb levels. The correlations were considered separately for each orbit, and they then were averaged by number of points in each orbit. The correlation coefficients r obtained in this manner are presented in Table 1. The number of pairs of points n, from which the correlation coefficient was calculated, also are presented here.

Values of the root mean error σ are presented in the last line of the table. It is evident from the table that the trend of the correlation function is not monotonic. This apparently is connected with the small volume of initial data, because of which the accuracy of the individual values of the correlation coefficient is comparatively low. Nevertheless, a good spatial correlation of the errors at different points, which amounts to about 0.6, even for distances on the order of 1000 km, is clearly evident from the table. In fact, it must be kept in mind that other errors in analysis of radiosonde data are superimposed on the indirect sounding /77 data, which should understate the actual level of correlation of the sounding errors. As is well-known [2], aerological temperature sounding data, even at the very point of observation, are characterized by a root mean error of 1° C and more. Taking account of the possible errors in spatial

TABLE 1

Mean scale distance km	850		700		500		300		200	
	r	n	r	n	r	n	r	n	r	n
125	0.456	6	—0.194	6	0.062	6	—	—	—	1
375	—0.020	16	—0.268	16	0.126	16	0.329	9	—0.338	7
625	0.778	60	0.718	60	0.655	59	0.658	29	0.341	44
875	0.630	67	0.615	68	0.538	65	0.554	32	0.355	54
1125	0.560	89	0.564	91	0.552	87	0.629	43	0.094	70
1375	0.678	29	0.604	29	0.691	28	0.502	13	—0.246	23
1625	0.611	36	0.614	37	0.780	35	0.334	15	0.430	27
1875	0.239	42	0.456	42	0.598	39	0.734	20	0.309	31
2250	0.410	67	0.412	70	0.401	67	0.414	31	0.272	53
2750	0.452	30	0.618	32	0.446	29	—0.268	12	0.064	23
3250	—0.121	36	—0.327	38	0.011	36	0.331	17	0.043	31
3750	0.126	16	0.342	16	0.068	14	—0.752	7	—0.360	11
4500	0.069	19	0.328	22	0.086	22	—0.113	16	—0.056	15
5500	—0.126	14	—0.337	15	0.063	15	0.288	14	0.886	6
σ, °C	3.43		3.30		2.80		2.36		2.25	

interpolation, the error of the "standard" can significantly exceed these errors, especially in regions with a sparse network of stations. If this is taken into account, it is understandable that the error correlation actually is not 0.6 for the distance mentioned, but a considerably greater value. It also is seen from the table that the correlation remains positive at all levels, up to distances of about 2500 km, i.e., approximately up to those distances, up to which a positive connection between changes in the actual temperatures is preserved.

A comparison of the correlations at different levels shows that the lowest correlation proves to be at the 200 mb surface, which is connected with the accuracy of the analysis at this level for the actual temperature (i.e., the accuracy of the "standard" is considerably less than at lower levels [2]).

Together with the error correlations at various points at one and the same level, an evaluation of the error correlation at different levels

at the same points was carried out. The results of this evaluation are presented in Table 2, where r is the correlation coefficient and σ_r is the root mean deviation of the correlation coefficient.

TABLE 2

Level	700		500		300		200	
	r	σ_r	r	σ_r	r	σ_r	r	σ_r
850	0.352	0.442	0,141	0.416	0.133	0.495	0,164	0.465
700	—	—	0.328	0.478	—0,057	0,330	—0.125	0.463
500	—	—	—	—	0,036	0.436	—0.138	0.435
300	—	—	—	—	—	—	0,266	0,436

It is evident from the data in the table that the correlation coefficients between the indirect sounding errors at different levels is very low, and that their values do not exceed the significance level. It can be concluded from this that there is practically no vertical correlation. This is apparently connected with the method of processing indirect sounding data adopted, in the course of which the sounding data are tied into the forecast field for each level.

It must be emphasized in conclusion that the estimates which we obtained on limited data are only preliminary. However, there is no doubt of the fact that there is a large spatial coherence in the errors of indirect satellite sounding. Further detailed study of the structure of these data appears to be necessary.

REFERENCES

1. Boltenkov, V. P., "Study of statistical macrostructure of air temperature," Trudy GGO, No. 165, 1965.

2. Boltenkov, V. P., "Some characteristics of the three-dimensional macrostructure of air temperature," Trudy GGO, No. 191, 1966.

3. Gandin, L. S., "Problems in four-dimensional assimilation of meteorological observation data," Meteorologiya i gidrologiya (3) (1971).

4. Gandin, L. S., Boltenkov, V. P., "Method of objective analysis of actinometric data from meteorological Earth satellites," Trudy GGO, No. 166, 1964.

5. Kondrat'yev, K. Ya., Timofeyev, Yu. M., Termicheskoye zondirovaniye atmosfery so sputnikov [Thermal Sounding of the Atmosphere from Satellites], Gidrometeoizdat Press, Leningrad, 1970.

6. Smith, W. L., Woolf, H. M., Jacob, W. J., "A regression method for obtaining real-time temperature and geopotential height profiles from satellite spectrometer measurements and its application to Nimbus-3 "SIRS" observations," Monthly Weather Review, 98, (8) (1970).

7. Smith, W. L., Woolf, H. M., Fleming, H. E., "Retrieval of atmospheric temperature profiles from satellite measurements for dynamical forecasting," Journal of Appl. Meteorol., 11, (1) (1972).